IN THE CLAIMS - MARKED UP VERSION

1) A nozzle heater-cooler assembly, (for heating and cooling a nozzle) comprising:

a) a hollow cylindrically shaped cartridge that contains an electrical element that contacts flat against the bottom surface of a housing;

b) a spring biasing (that biases) said cylindrically shaped cartridge (that contains a electrical element housing to an elevation that has a lower altitude than said nozzle with a groove elevation) to lower as measured from the base of a (said) nozzle hub (forcing deflection of said spring that surrounds said cylindrically shaped cartridge to enable a change in altitude) to enable a change in position of said electrical element;

c) a second larger diameter cylindrically shaped body that said cylindrically shaped cartridge and said spring are fit surrounds the cartridge and spring;

d) a central opening means for allowing said heater-cooler assembly to slide on body of a (said) nozzle and moveable from an unlocked position with (a) main slide retracted from (said) a nozzle with a groove to a locked position with said main slide extending into said nozzle with a groove;

e) (a) an electrical path through metallic rods and springs to enable conductors to fit in a small space and allow movement by translation of said electrical path along one axis a series of dissimilar metal rods with a common heat conduction pad that enables electrical connection of all said dissimilar metal rods;

f) a convective cooler design for said nozzle that simultaneously directs pressurized gas along each face of a hexagonal shaped hub;

g) a resistive element design composed of two elements on parallel planes, electrically connected in a series circuit.

2) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein a change in (altitude) <u>position</u> of said electrical element divided into the perimeter of the heated space exceeds one.

3) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said second larger diameter cylindrically shaped body that said cartridge and said spring are fit is about 50mm in diameter and 25 to 40 mm in height.

4) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said hollow cylindrically shaped cartridge that contains said electrical element that contacts flat against the bottom surface of said housing is between 8 mm to 20 mm in diameter.

5) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said resistive element design composed of two elements on parallel planes, electrically connected in a series circuit are helix shaped windings of high resistance metallic conductor with a resistance somewhere between 50 and 250 ohms.

6) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said central opening means for allowing heater-cooler assembly to slide on body of said nozzle and moveable from an unlocked position with said main slide retracted from said nozzle <u>with a groove</u> to a locked position with said main slide extending into groove on said nozzle is a flat guillotine mounted slide perpendicular to the axis of the cylindrical body occupying a slot through the part preventing egress of said cylindrically shaped cartridge and said spring that biases said cylindrically shaped cartridge <u>with a groove</u>.

7) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said central opening means for allowing said heater-cooler to slide on body of said nozzle and moveable from an unlocked position with said main slide retracted from said nozzle groove to a locked position with said main slide extending into said groove on said nozzle hub is locked by means of an outwardly extending retaining member.

8) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said hollow cylindrically shaped cartridge that contains said electrical heating element (which) <u>that</u> (is in contact) <u>contacts</u> flat against the bottom surface of a thermally conductive, electrically insulating housing resting on an interior lip extending around the inside perimeter of said cylindrically shaped cartridge, conducts heat into the enclosed space containing and surrounding said nozzle.

9) The nozzle heater-cooler assembly (for heating and cooling a nozzle hub and or nozzle core) of Claim 1, wherein said second larger diameter cylindrically shaped body that said cylindrically shaped cartridge and said spring are fit utilizes o-rings to seal the interface between said cylindrically shaped cartridge and said larger diameter cylindrically shaped body (from gas pressure loss).

10) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said resistive element design composed of two elements on parallel planes, electrically connected in series are out of phase 180° in comparison of a lower element winding start to a upper element winding start around a concentric cylinder.

11) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said series of dissimilar metal rods that contact a common heat conduction pad which enables electrical connection of all the (said) dissimilar rods to form a series circuit pair wise, any two said dissimilar metal rods will produce discrete thermocouple types.

12) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said, convective cooler design for a nozzle that simultaneously directs pressurized gas along each face of said hexagonal shaped hub uses a diffuser to direct and distribute cooling gas to each face of the hexagonally shaped nozzle base.

13) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said central opening means for allowing said heater-cooler assembly to slide on body of said nozzle and moveable from an unlocked position with said main slide retracted from said nozzle with a groove to a locked position with said main slide extending into said nozzle with a groove and has an integral abutment and said lower body includes an abutment that are coincident when lock is in the normally closed position and are closely spaced when locked to said nozzle body.

14) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1 wherein said central opening (means for allowing said heater-cooler to slide on body of said nozzle and moveable from an unlocked position with said main slide retracted from said nozzle groove to a locked position with said main slide extending into groove on said nozzle and) is sealed around the nozzle body outside diameter using a seal clamped to the heater-cooler upper body (to prevent contaminates from entering into the bore).

15) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1 wherein said electrical path through said metallic rods and said springs (to enable) permits conductors to fit in a small space and allow movement by translation of said electrical path along one axis, (uses) pins from the integral connector also function as the cantilever springs that are in intimate contact with the rods in each groove to enable construction of sliding discrete connections.

16) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1 wherein said resistive element design composed of two elements on parallel planes, about 0.1 mm to 2 mm but more preferably 0.1mm to 1mm apart.

17) The nozzle heater-cooler assembly (for heating and cooling a nozzle) of Claim 1, wherein said central opening means for allowing said heater-cooler to slide on body of said nozzle hub and moveable from an unlocked position with said main slide retracted from said nozzle hub groove to a locked position with said main slide extending into groove on said nozzle hub with enough force to resist any strong movement but allow rotation so as not to exert torque on said nozzle hub.

18) A nozzle hub for connection and support of a (said) nozzle heater-cooler has a groove that extends concentrically around the hub body circumference, which can be continuous or intermittent in 360° of rotation at (an altitude) a distance that exceeds the depth of (said) an element housing installed in a (the) spring biased cartridge.

19) A nozzle heater-cooler apparatus, (for heating and cooling said nozzle) comprising:

a. an input port for cooling gas flow into the heater-cooler (assembly) apparatus;

b. an integral electrical connector molded into the lower body of the (assembly) apparatus for electrical input and temperature data output;

c. connection logistics for the heater-cooler apparatus (assembly requires) require (said) a large diameter cylindrically shaped body to integrate triangular protrusions opposite (said) a main slide.

20) The nozzle heater-cooler apparatus (for heating and cooling said nozzle) of Claim 19, connection logistics (for the heater-cooler assembly) require said large diameter cylindrically shaped body to integrate triangular protrusions opposite said main slide, (radii across the rear legs of the triangular protrusions) said triangular protrusions provide structure to form generous (rear leg) radii across (are) large enough to fit index finger and forefinger to enable use of thumb for actuation of said main slide.

IN THE OBJECTS AND ADVANTAGES - AMENDED VERSION

Accordingly, the design of the fluid path heater has inherent objects and advantages that were not described earlier in my patent. Several additional objects and advantages of the present invention are:

(1.) To provide a design for a heating device that requires no tools to install or remove on a hub.

(2.) To provide a design for a nozzle or needle hub that clamps the heater tightly to the hub with the necessary force to withstand any strong movement, but allows rotation so as not to exert any torque that could loosen the hub and cause process interruption from tip loosening.

(3.) To provide a design for a nozzle or needle hub that encloses or contains the space surrounding the nozzle in an environment that stops the effect of external influences on change in temperature.

(4.) To provide a design for a nozzle or needle heater element that can be produced, using thermally efficient, conductive metals. Aluminum Al is the best candidate because the oxide form Al_2O_3 is not electrically conductive, but is thermally very efficient. The oxide layer is deposited on the surface of an aluminum part by a process known as anodization. Various grades exist; however, the most resistant form to abrasive wear is referred to as hard anodization in the industry.

(5.) To provide a design that is capable of transforming electrical energy into thermal energy without electrically overloading the resistive element; and, enable plug in installation into existing systems to proliferate the use of the technology in the industry.

(6.) To provide a design that compensates for variation in height of the nozzle hub so intimate contact between the flat base of the hub and the flat heated face of the element always, occurs.

(7.) To provide a design for an element that has exceptionally small thermal mass to elicit a rapid response rate for a given thermal cycle. Element temperature can be kept elevated above ambient but lower than set point, the fluid path experiences a smaller delta temperature with each thermal cycle. The thermal reservoir in the heating system resides within the nozzle hub.

(8.) To provide a design, wherein no fasteners are used in the assembly, parts are held in place by inherent geometric relationships, there are no threaded fasteners to loose.

(9.) To provide a design that has an integral connector for integration of a replaceable cable for connection of power and multiple outputs for sense of temperature.

(10.) To provide a design that uses rods instead of wires within the assembly for sense of temperature or transmission of electrical power.

(11.) To provide a design that has a small diameter and a thickness less than a US dime, thermal mass is minimized to enable rapid thermal response to energy input.

(12.) To provide a design for an electrical heating cartridge that can supply cooling gas across the faces of a hexagonally shaped nozzle hub for convective transfer of heat out of the system.

(13.) To provide a design that has the provision for multiple temperature outputs for comparison, validation and/or monitoring.

(14.) To provide a design that can seal off against fluid migration in the event of pump, valve or operator malfunction. This is accomplished using a silicone washer clamped in place around the entrance to the nozzle heater. The tight fitting inside diameter of the elastomer stretches around the circumference of the nozzle hub at the entrance of the heater bore, sealing the assembly.

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IN THE DESCRIPT1ON OF THE DRAWINGS - FIGURES - AMENDED VERSION

Turning now to the drawings wherein numbers identifies elements and like elements are identified by like numbers throughout the nine figures, the novel design of a nozzle heater-cooler 1 is depicted in ***Figures 1, 2*** and ***4-8***. ***Figure 0*** is an illustrative view at 2:1 of the Prior Art; two versions of the same style heater are shown as well as an illustration of the interior electrical components present in the devices. ***Figure 1*** is an illustrative view of the invention from an elevated vantage point at a scale of 4:1. ***Figure 2*** is an illustrative view of the underside of the invention also at a scale of 4:1. ***Figure 3*** at an approximate scale of 5:1 is an illustration of nozzle designs used with the nozzle heater –cooler. The pictorial ***Figure 3*** shows the hub groove 0 the attachment position for the heater–cooler assembly for different nozzle types or versions. The reusable hub 3 and disposable nozzle core 2 are installed in the nozzle heater-cooler illustrated in ***Figures 1*** and ***2***. The brazed one-piece nozzle 4 is another alternative nozzle configuration that can be used in the nozzle heater-cooler. Generally, when increased cost over the disposable core 2 and reusable hub 3 is not an issue and the application demands the increased thermal performance. ***Figure 4*** is an illustrative exploded view of the details that comprise the invention shown in ***Figures 1*** and ***2*** the parts in the drawing are at an approximate scale of 2:1. ***Figure 5*** is an exploded view of the heater element assembly 20 at an approximate scale of 5:1, construction of the assembly requires the element housing 19 with resistive elements 14 and 17 and thermocouple contact pad 13 with electrically insulating spacers 16, 18 to separate the resistive elements 14 and 17, the contact ring 15 is the means for connection of the two resistive elements 14 and 17 which lay on parallel planes connected in series. ***Figure 6*** is an exploded view of components assembled to construct the heater-cooler cartridge 29 at an approximate scale of 3:1, depicting thermocouple 22, 23, 24, 25 and power connection rods 21, which are normally shrouded by the diffuser 26 when assembled. ***Figure 7*** is an illustrative view of related heater-cooler cartridge 29 parts. The view is from a vantage point elevated above the cartridge assembly at an approximate scale of 3:1and omits the diffuser 26 to see the thermocouples 22, 23, 24, 25 and power connection rods 21 installed in their respective in service positions. ***Figure 8*** illustrates a view from an elevation above the resistive element looking straight down on both. It is easy to see with no spacers installed the two resistive elements have the same pitch but, start out of phase by 180°; this allows the winding of element two 14 to be located between windings of element one 17 in the element housing designed for containment of the fragile element windings 14, 17.

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